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GB1571548 A EP 0569754 A1
EP 0099129 A2 US 5563333 A

EP 0150266 A2
US 4646558 A

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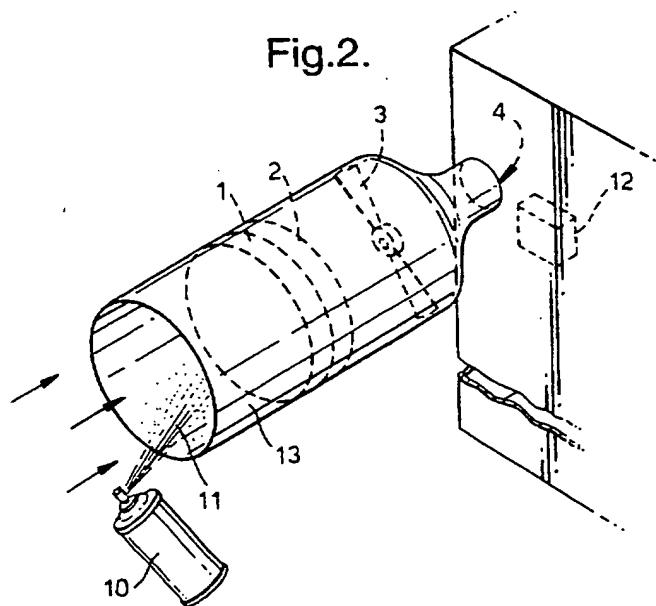
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(54) Abstract Title

Method and apparatus for testing filters

(57) A method for the testing of a filtration system 1-4 comprises the sequence of releasing a material 11 into a gaseous carrier, passage of the gaseous carrier through filtration means 1 and 2 and sensing 12 for the presence of the material in the gaseous carrier which has passed through the filtration means. An apparatus for carrying out the method comprises a material 11, release means 10, and detection means 12. The release means preferably forms an aerosol of the material, especially by using an aerosol spray canister. Optionally the material can be released by a smoke generating means, such as a smoke bomb. The detection means may be a light scattering device, condensation nuclei counter, photoelectric device, ionisation detector or chemical warfare detector. The material can be methyl salicylate. The apparatus may include ducting means 13 connectable to the input of the filtration system.

Fig.2.



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Fig.1.

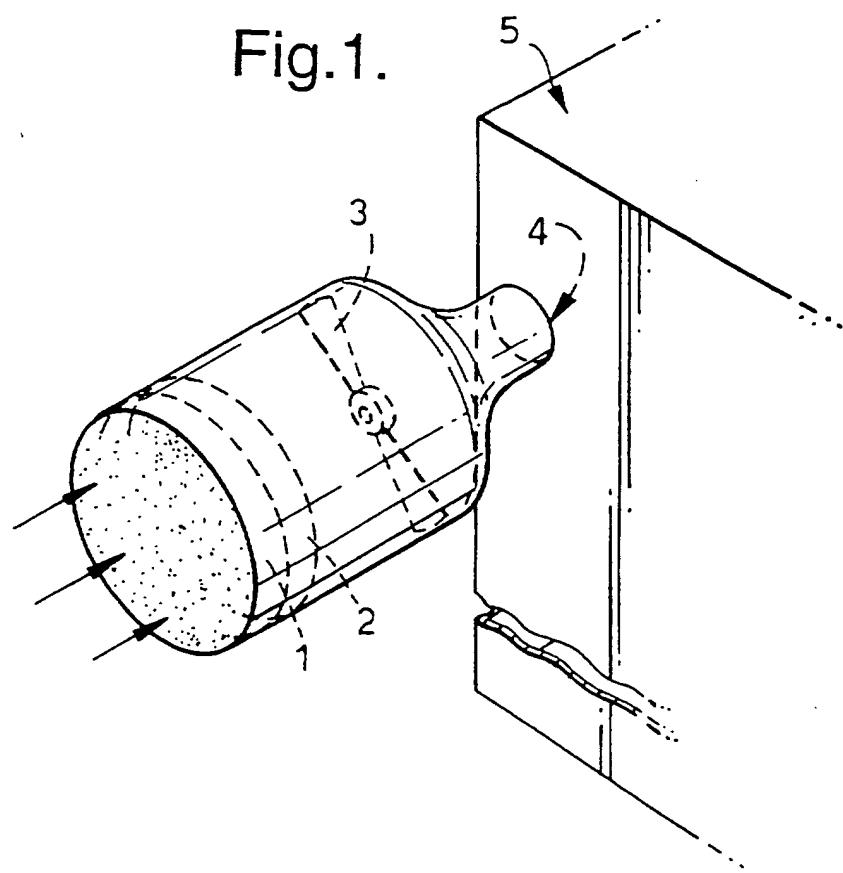


Fig.2.

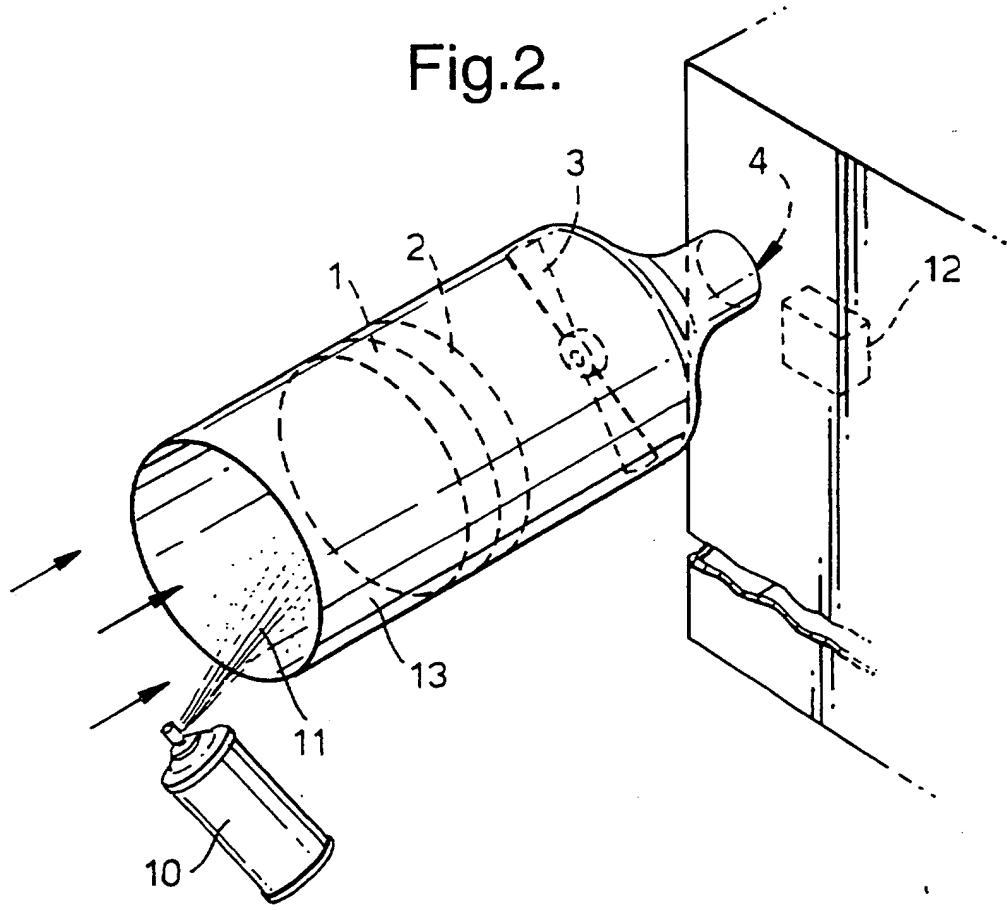


Fig.3.

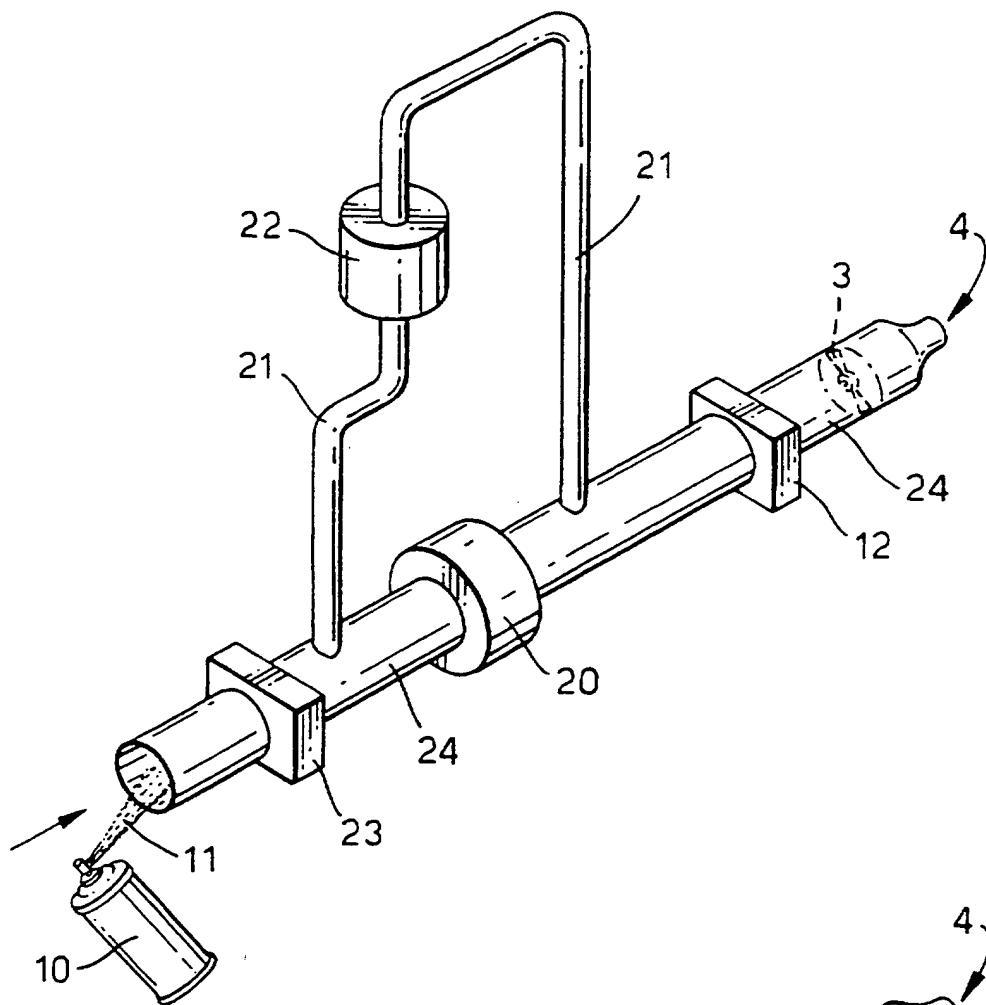
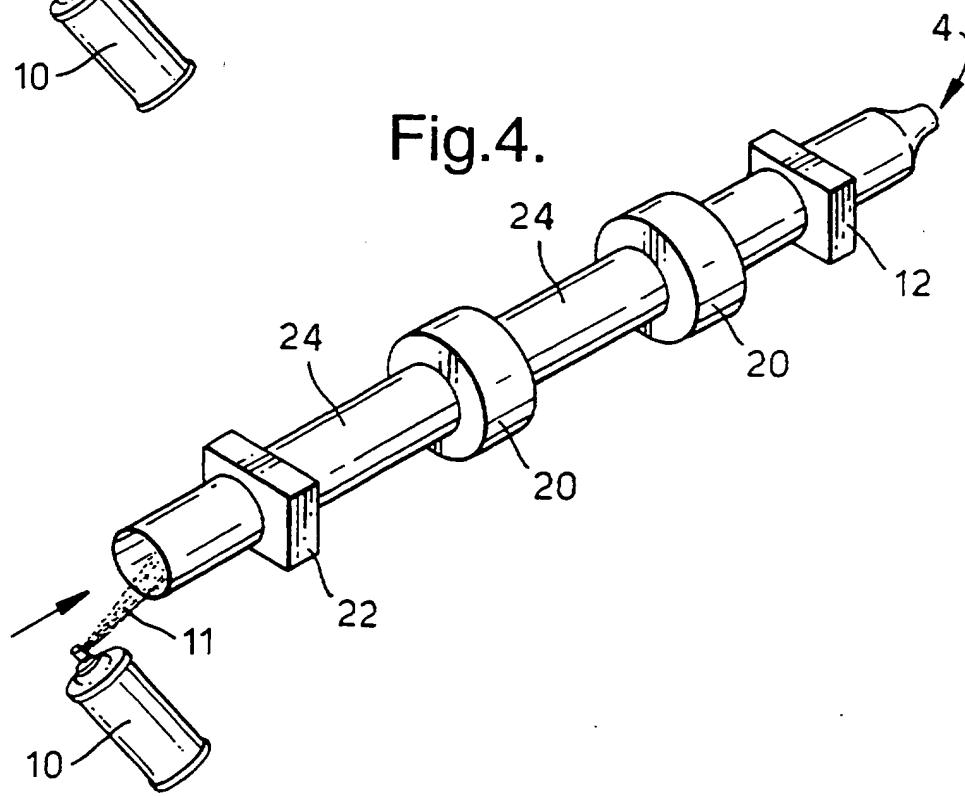


Fig.4.



Test method and kit

This invention relates to the field of the testing of filter systems, particularly, but not exclusively, 5 collective protection filtration systems (COLPROs).

COLPROs are installed in various buildings, ships, land-based vehicles, tents, transportable container bodies and other facilities that may be susceptible to attack by chemical or biological weapons. The system is 10 designed to remove dangerous particulate, chemical, biological and biochemical materials from contaminated air, thus providing clean, toxin-free air for the facility to be protected. Such a typical filtration system comprises a fan, a pre-particulate filter, a high 15 efficiency particulate air (HEPA) filter and a carbon anti-vapour filter. The filters in such a system have a finite life and must be changed after a given time or after a certain number of attacks. The incorrect fitting of a filter, filter damage or damage to air-tight seals 20 can seriously decrease the effectiveness of COLPRO. In the case of large vehicles, such as ships, and permanent building structures, the efficacy of the COLPRO can be tested using established non-destructive techniques. These tests measure the vapour and particulate filtration 25 efficiencies of the respective filter stages, and are conducted by skilled technicians using sensitive and expensive test apparatus.

The high cost and logistic difficulties associated with testing mobile platforms such as tents, armoured 30 fighting vehicles and transportable container bodies preclude such testing. Hence the platform user has no way of knowing whether the associated filtration system is providing a safe environment in which the user can function without wearing full Individual Protective 35 Equipment (IPE). For this reason, users have little confidence in the ability of the COLPRO to provide adequate protection and would don IPE during an attack.

In such a scenario the benefits of COLPRO are negated. Furthermore, IPE can impair user performance and there is some evidence to suggest that IPE has negative psychological effects on the wearer. Hence, there is a 5 need for a simple, robust and inexpensive method for verifying the satisfactory performance of COLPRO facilities. The invention in suit provides such a method.

In accordance with a first aspect of the present 10 invention, a method for the testing of a filtration system comprising in sequence
a) release of material into a gaseous carrier;
b) passage of the gaseous carrier through filtration means; and
15 c) sensing for the presence of the material in the gaseous carrier which has passed through the filtration means.

This gives a simple and convenient method for the testing 20 of filtration systems.

The release of the material may be effected by the formation of an aerosol of material in the gaseous carrier. This is preferably achieved using one or more 25 aerosol spray canister. This provides a simple, inexpensive, robust and generally safe manner of releasing the material.

In this method, the sensing of the presence of the 30 material may be effected by the use of a detection means. This provides a manner of determining how well the filtration system is working.

In one arrangement of the method, the material comprises 35 particulate matter. The particles are of such a size to test the efficiency of the particulate filters in the

filtration system, such as HEPA filters.

The particulate material may be smoke or other sub-micron particles and the release of the smoke may be effected by
5 the use of smoke generating means, which may comprise one or more smoke-generating machines or one or more smoke bombs. The smoke contains particles of sub-micron size which are the correct size to test the integrity of the particle filters. The smoke bombs are cheap, easy to use
10 and readily-available, whilst smoke generating machines provide large volumes of smoke for a long period. Most preferably the release of particulate material may be effected by the use of an aerosol spray means, such as an aerosol spray can. These cans are relatively safe, simple
15 to use and robust.

The detection means in the method preferably comprises a light scattering device. This device is simple to use. Alternatively, the detection means comprises a
20 condensation nuclei counter, an ionisation detector or a photoelectric device. The latter two devices are cheap, portable and simple to use.

In an alternative arrangement of the method in accordance
25 with the present invention, the material simulates one or more chemical warfare agent. The material has dispersal properties similar to that of one or more chemical warfare agents. The material is preferably non-toxic and safe to handle. Most preferably the material is methyl
30 salicylate (2-hydroxy benzoic acid methyl ester, or oil of wintergreen).

In the second embodiment of this aspect of the invention, the detection means preferably comprises a detector
35 suitable for the detection of chemical warfare agents, such as the GID III chemical warfare (CW) detector.

Advantageously, the gaseous carrier is ducted through ducting means prior to passage through the filtration system. The ducting means allows release of the material into the gaseous carrier at a point convenient for the user.

The filtration system may be a collective protection filtration system.

- 10 In this method, The filtration means may comprise at least one filter capable of removing particulate material from the gaseous carrier. Additionally or alternatively, the filtration means may comprise at least one filter capable of removing one or more chemical warfare agents
- 15 from the gaseous carrier. The method is suitable for the testing of systems that have at least one of particulate and composite filters (those having combined chemical and particulate filters).
- 20 In accordance with a second aspect of this invention, there is provided a kit for the testing of a filtration system comprising material, release means capable of releasing material into a gaseous carrier and detection means capable of sensing the presence of material in a gaseous carrier. Such a kit provides a simple and effective means for the testing of filtration systems.

In a preferred embodiment, the release means comprises an aerosol generation means capable of releasing an aerosol of material into the gaseous carrier. The aerosol generation means is most preferably one or more aerosol spray canister. This provides a simple, robust and safe way of introducing material into a filtration system.

35 In a further preferred embodiment, the kit comprises ducting means. This ducting is used to ensure that an intake to a filtration system experiences a high flux of

material. The ducting allows release of material to occur at a place convenient for the user of the kit.

The kit preferably further comprises a manometer. This
5 can be used to determine the air-flow and overpressure in a filtration system under test. This can be beneficial in determining the efficiency of the filtration system.

In an embodiment of the invention for testing particulate
10 filters, the release means comprises a means for the release of particulate material. This allows the kit to be used to test the efficiency of particle filters deployed within a filtration system. In this embodiment the means for the release of particulate matter may
15 comprise at least one smoke bomb. Smoke bombs are cheap and easy to use. Alternatively, the means for the release of particulate matter comprises at least one smoke-generating machine. These machines are capable of generating large volumes of smoke for long periods.

20
The detection means for use in this embodiment preferably comprises a light scattering device. This device is simple to use. Alternatively, the detection means comprises a condensation nuclei counter, an ionisation
25 detector or a photoelectric device. The latter two devices are cheap, portable and simple to use.

In a kit according to the present invention for testing chemical filters, the release means comprises a means for
30 the release of material whose dispersal properties are similar to that of certain chemical weapon agents. The kit can therefore be used to test the efficiency of the chemical filters deployed within the filtration system. Such filters are usually made of activated charcoal.

35
In such a kit for testing chemical filters, the detection means preferably comprises a detector capable of

detecting chemical warfare agents, most preferably the GID CW detector.

The material released by the release means is most
5 preferably methyl salicylate. This is a benign analogue
of a toxic chemical warfare agent. When dispensed via an
aerosol spray this material has similar dispersal
properties to certain known chemical warfare agents.

10 In the case of kits designed to test particulate and
chemical filters, the filtration system may comprise at
least one filter capable of removing particulate matter
from the gaseous carrier. Alternatively or additionally,
the filtration system comprises at least one filter
15 capable of removing one or more of chemical warfare
agents from the gaseous carrier.

The invention is now described by way of example only
with reference to figures 1 to 4 of which

20 Figure 1 is a schematic representation of a filtration
system that may be tested using the method and kit in
accordance with the present invention;

25 Figure 2 is a schematic representation of the use of a
kit in accordance with the present invention to test the
filtration system shown in figure 1;

Figure 3 is a schematic representation of the use of an
30 apparatus designed to test the efficiency of the kit and
method in accordance with the present invention; and

35 Figure 4 is a schematic representation of the use of
another apparatus designed to test the efficiency of the
kit and method in accordance with the present invention.

Figure 1 shows a typical filtration system that may be tested using the method and kit in accordance with the present invention. The filtration system comprises a particulate filter 1, a chemical filter 2, a motor-
5 powered fan 3 and an air inlet 4 defined by an aperture in a facility 5. The filtration system is designed to provide clean, non-toxic air to the facility 5. When the fan 3 is activated air flows in the direction of the arrow through the particulate filter 1 and chemical
10 filter 2 into facility 5 via the air inlet 4. Thus the air provided to the facility 5 has passed through the filtration means particulate filter 1 and chemical filter 2, and should therefore be devoid of toxic particulate material and chemical warfare agents. The filters 1, 2
15 and fan 3 are sealed in an air-tight manner to ensure that air ingress to the facility 5 is only possible through the filtration system via the external face of particulate filter 1. The fan 3 is connected to the air inlet 4 by air-tight connection means (not shown).
20 Furthermore, the facility 5 is designed to be substantially air-tight except for the permitted air ingress via the air inlet 4. The particulate filter 1 is typically a HEPA filter with more than 99.997% efficiency for the particles of target size. This is designed to
25 remove particulate material from the air flowing through the filtration system. The chemical filter 2 is often made from activated charcoal and is designed to remove potentially toxic chemical agents from the air flowing through the filtration system. The size of the filters 1,
30 2 and air inlet 4 and the power of the fan 3 will depend on the rate at which air needs to be delivered to the facility 5. This, in turn, will depend on the size of the facility 5 and the nature of work that is performed therein. The facility 5 is typically an armoured vehicle,
35 tent or transportable container body. Note that the particulate filter 1 and chemical filter 2 may be used as

separate filter bodies or may be integrated so as to form only one filter body.

When working satisfactorily, the filtration system supplies non-toxic air to the facility 5. The filters 1, 5 2 have a finite operational lifetime and must be changed after a given deployment period or after a certain number of attacks, whichever is earlier. The incorrect fitting of a filter 1, 2, filter damage or damage to air-tight seals or connection means (not shown) can significantly 10 decrease the effectiveness of the filtration system, and thus compromise the safety of occupants of the facility 5. It is rarely possible to use known techniques to measure the effectiveness of the filtration systems in the facilities 5 such as tents and vehicles, since these 15 techniques require the operation of complex and sensitive equipments by skilled, trained personnel. Hence, there exists a need for a cheap, robust and effective method (and associated kit) for the testing of filtration systems. Such a method and kit should be usable by 20 unskilled personnel who have received a minimal amount of training. The method and kit in accordance with the present invention satisfy these needs. Examples 1 to 3, 12 and 13 give details of such kits and methods, whilst examples 4 to 11 give details of how such kits and 25 methods are tested and used in practice.

Example 1 - kit and method in accordance with the present invention for the testing of filtration system

30 Figure 2 is a schematic representation of the use of a kit in accordance with the present invention to test the filtration system shown in figure 1. The kit comprises release means 10, material 11, detection means 12 and ducting means 13. The release means 10 is capable of 35 releasing the material 11 into a gaseous carrier (not shown). The method in accordance with the present invention comprises release of material 11 into a gaseous

carrier, passage of the gaseous carrier through the filtration system and sensing for the presence of the material 11 in the gaseous carrier that has passed through the filtration system. The sensing is performed 5 using the detection means 12.

The filtration system as previously described is preferably turned-on prior to the performance of the test such that the fan 3 causes air to pass in the direction 10 of the arrow through ducting 13, filters 1 and 2, air inlet 4 and into the facility 5. The release means 10 is, in this case, an aerosol spray canister. Activation of release means 10 produces an aerosol of material 11 near the external opening of the ducting 13 into a gaseous 15 carrier. The gaseous carrier in this case is the air that the fan 3 causes to flow through the filtration system. The air-flow created by fan 3 causes material 11 to pass through the ducting 13 to the external face of particulate filter 1. If the filtration system is working 20 properly then virtually no material 11 should pass through the filtration system to air inlet 4. If this is the case, then detection means 12 is such that it will not sense the presence of material 11. If the filtration system is defective (for example, one or both of the 25 filters 1 and 2 has been damaged, creating a hole therein through which material 11 can pass), then the detection means 12 will sense the presence of material 11.

Note that the ducting 13 and use thereof are not 30 essential integers of the kit and method respectively in accordance with the present invention. The ducting 13 permits the introduction of material 11 into the gaseous carrier as an aerosol from a convenient access point and ensures that a relatively large amount of material 11 is 35 incident on the anterior face of filter 1.

The kit and method in accordance with the present invention will now be described with reference to particular examples directed at testing the ability of the filtration system to remove particulate matter and 5 chemical matter respectively.

Example 2 - kit and method for testing ability of filtration system to remove particulate material from gaseous carrier

10

The kit and method are generally as described in Example 1. The material 11 is particulate material and is dispensed in an aerosol by activation of release means 10, which is, in this case, an aerosol spray can. The 15 detection means 12 is a light scattering device. The spray can may be of the type used to test domestic smoke alarms.

Alternatively the release means 10 may be a smoke-generating machine such as the MiniMist machine, or a smoke bomb. Both alternative means are capable of producing an aerosol of particulate matter. The detection means may alternatively be a condensation nuclei counter, an ionisation detector or a photoelectric device.

25

Example 3 - kit and method for testing ability of filtration system to remove chemical material from gaseous carrier

30 The kit and method are generally as described in Example 1. The material 11, methyl salicylate, whose dispersal properties are similar to those of certain chemical warfare agents, is dispensed in an aerosol by release means 10, in this case an aerosol spray can. The 35 detection means 12 is a detector suitable for use in chemical warfare, such as the GID CW detector.

11

Example 4 - testing of kits and method in accordance with
the present invention

The kits and method in accordance with the present
5 invention and as described in examples 1-3 above were
tested as shown in figure 3. The apparatus used in the
testing (excluding those components comprising the kit in
accordance with the present invention) comprises a filter
20, tubing 21, 24 and flow meters 22, 23. The other
10 components and their modes of operation have been
previously described. The test was designed to permit the
introduction of controlled leaks such that the detection
means 12 was subjected to the presence of material 11.
This allowed one to assess the sensitivity of the kit and
15 method in accordance with the present invention. An
aerosol of material 11 dispensed by release means 10 is
drawn through the tubing 24 and the first flow meter 23,
onto the upstream face of filter 20 by the fan 3. The
filter 20 may be a particulate filter 1 or chemical
20 filter 2 capable of removing particles and chemicals
respectively from the stream of air. The choice of filter
20 is determined by the nature of material 11. A high
proportion of the material 11 that is released into the
tubing 24 is incident upon the upstream face of the
25 filter 20. However, an open end of a second length of
tubing 21 is abutted onto tubing 24 in a position
upstream of the filter 20 such that a small proportion of
material-bearing air (relative to that incident on the
upstream face of the filter 20) passes through the second
30 length of tubing 21, through the second flow meter 22 and
then into tubing 24 downstream of the filter 20. The
material 11 in the airflow which by-passed the filter 20
is sensed by the detection means 12. Hence, by
controlling the airflow through the tubing 21, for
35 example by a valve (not shown) the effect of a variable
leak can be simulated and hence the amount of material
incident upon the detection means 11. The flow rates

measured by flow meters 22 and 23 indicate the relative amount of material 11 that by-passes the filter 20.

Examples 5 - testing of the kit and method of example 2
5 using the method and apparatus of example 4

The kit and method of example 2 in accordance with the present invention were tested using the method and apparatus of example 4. In all cases the filter 20 is a
10 HEPA particulate filter. The integrity of each filter was tested prior to use and found to be satisfactory.

Example 5a

Release means 10 was an aerosol spray canister used in
15 the testing of smoke alarms. The canister was activated for 15 seconds to release material 11 as an aerosol into the tubing 24. The detection means 12 was a light scattering device, in this case a DualTrak aerosol monitor. A 1 litre/minute leak in a flow of 170m³/hr.
20 (0.035% leak) caused a noticeable rise in the signal from the detection means 12 during the challenge period (i.e. the period for which the filter 20 is subjected to exposure to the aerosol). The response of the detection means 12 returned to background levels shortly after
25 exposure to the material 11 had finished.

Example 5b

Release means 10, a MiniMist smoke-generating machine, was activated for 15 seconds to release material 11 into
30 the tubing 24. The detection means 12 was a DustTrak aerosol monitor. A 0.25 litre/minute leak in a 170m³/hr. flow (0.009% leak) lead to a prominent rise in the signal from the detection means 12.

35 Example 5c

Release means 10 was an aerosol spray canister used in the detection of smoke alarms. The canister was activated

for 15 seconds to release material 11 as an aerosol into the tubing 24. The detection means 12 was a Portacount Tester, a condensation nuclei counter. The response of the counter was monitored as the size of the leak was 5 changed. The results are summarised below in Table 1. An air flow of 170m³/hr. was used in each case.

% induced leak	Particles/cm ³
0	20.9±1.1
0.007	22.3±1.6
0.018	25.7±1.7
0.07	46.6±4.7
0.175	45.2±1.0
0.35	63.5±2.4

Table 1 - response of Portacount detector as a function of the size of the induced leak

10

This indicates that the kit and method are effective at detecting leaks of 0.018% or greater, although leaks at a lower level may be detected, given an indication of a response at a leak level of 0.007%.

15

Example 5 illustrates that the kit and method in accordance with the present invention can be used with great effect to test the performance of filtration systems comprising particulate filters.

20

Examples 6 - testing of the kit and method of example 3

Example 6a

The kit and method of example 3 were tested using the 25 method and apparatus shown in figure 4. All of the constituent parts have been described previously. The release means 10 comprises 1 or 2 aerosol spray canisters filled with material 11 (in this case, methyl salicylate). The release means 10 is activated for 15

seconds so as to release material 11 as an aerosol into the gaseous carrier (not shown) which is air flowing at either 85 or 170 m³/hr. The material 11 is transported by the gaseous carrier to the anterior face of the filter

5 20. The filter is an NBC No.1 composite filter that comprises an activated charcoal filter capable of removing chemical warfare agents from incident air and a HEPA filter for removing particulates from the incident air. Holes of known diameter were drilled into the

10 filters, permitting the flow therethrough of material 11. The presence of the material 11 in the gaseous carrier was then detected by the detection means 12. The detection means 12 was a GID III CW detector. The response of the GID detector was measured as a function

15 of size of the hole, filter penetration, air flow and the number of spray canisters used. The results of this investigation are summarised in Table 2 below. A reading of 1 bar was taken as being indicative of the presence of material 11. Filter penetration was determined using the

20 standard NaCl aerosol test (REF). This was possible since the No. 1 filter also has a particulate filter element.

No. of spray cans	Hole size (mm)	Air flow (m ³ /hour)	Penetration (%)	Detection (Y[es] or N[o])
1	2.0	170	0.41	Y
		85	0.82	Y
	1.5	85	0.31	Y
	1.0	85	0.069	Y
	0.75	85	0.031	Y
2	1.0	170	0.053	Y
	0.75	170	0.015	Y
	0.75	85	0.031	Y
		85	0.006	N

Table 2 - response of the GID detector

The results of Table 2 indicate that the kit and method of example 3 are suitable for the testing of a filtration system. The results obtained using only 1 spray can indicate that lower penetrations (smaller leaks) are

5 detectable at lower rates of air flow. It should be noted that the use of 2 cans as opposed to 1 improved the speed of response of the detector. The detector also gave a positive reading for a longer period. This may be beneficial in certain circumstances. Sensitivity is also

10 increased at higher flow rates.

Example 6b

It was also possible to test chemical filters 2 not comprising a particulate filter 1 using the method and

15 apparatus of figure 4 by the insertion of a HEPA particulate filter upstream of the filter to be tested

20. Using this methodology it was possible to detect holes of 1.5-2.0mm diameter in a NBC No.5 filter, which comprises an activated carbon filter for removing

25 chemical warfare agents only. The NBC No. 5 filter does not contain a HEPA filter capable of removing particulate from the incident air. Assuming that the holes create a similar penetration level to those recorded in example 6a above, then this would indicate a sensitivity of about

25 0.5%

Example 6a and 6b indicate that the kit and method of the present invention can be used to test the ability of filtration systems to remove CW agents.

30 Example 7 - testing of the kit and method of example 2 using the apparatus and method of example 6

35 The testing of the kit and method of example 2 can be performed using the apparatus and method of example 6, with only minor modifications. The GID detector is replaced with a suitable particle detector and the filter

20 is a holed particulate filter 1. The release means 10
should release particulate material, rather than an
aerosol of a chemical capable of simulating a CW agent.
The penetration of the filter 1 can be measured using the
5 state of the art NaCl method (REF).

The kit and method according to the present invention
were also tested in the field on VLSMS and Challenger
tanks as outlined in examples 8 to 11 below.

10

Example 8 - particulate filter test on VLSMS

A 4m length of 6" diameter flexible ducting means 13 was
connected to the main air intake of the NBC system using
an adapter means. The outlet from the scavenge fan of the
15 cyclone filter was then sealed and the scavenge filter
disabled to prevent loss of material 11. The efficiency
of the particulate filter 1, in this case a HEPA filter,
was determined using standard NaCl test apparatus. 3
holes, each made by a 0.7mm diameter drill bit, were then
20 drilled into the HEPA filter, and the NaCl test repeated
to determine the penetration of the holed filter 1. The
penetration increased from 0.0034% (no holes) to 0.043%
(3 holes).

25

The leaking filter 1 was refitted into the VLSMS.

Material 11 was released into the end of the ducting
means 13 using either an aerosol spray canister or a
MiniMist smoke-generating machine. The detection means 12
was placed inside the vehicle close to one of the air
30 outlets. The challenge concentrations generated by the
spray can were measured by sampling from the inlet duct
at the duct/filter interface. The leaking filter 1 was
tested using the DustTrak and Portacount detectors. Both
detectors were capable of detecting the 0.04% leak, using
35 either the spray can or the MiniMist generator as release
means 10.

Tests were then conducted which involved spraying the challenge directly in the inlet of the NBC pack to determine whether the test could be simplified by obviating the use of ducting means 13. Both detection 5 means 12 detected the presence of the 0.04% leak using either of the spray canister or MiniMist release means 10.

Example 9 - particulate filter test on Challenger tank
10 One of the two No. 1 filters of the NBC pack was replaced by a filter that had been modified to produce a known leak. Holes were drilled into the filter 1 using 0.5mm, 0.75mm, 1.0mm, 1.5mm and 2.0mm drill bits. The 1.5mm and 2.0mm hole gave penetrations of 0.074% and 0.098%
15 respectively as determined by the standard NaCl technique. Various combinations of the holes were covered to control the size of the leak in the filter 1. A detector was placed near the air outlet inside the vehicle. It was found that the 0.75mm diameter hole was
20 readily detectable using either of the DustTrak or Portacount detectors, and using either the spray canister or MiniMist as release means 10.

Examples 8 and 9 indicate that the kit and method of the 25 present invention can be used in the field to test the efficacy of filtration systems comprising particulate filters.

Example 10 - chemical filter test on VLSMS
30 The general methodology of example 8 was followed, but the detection means 12 was a GID III CW detector. Furthermore, the material 11 was methyl salicylate dispensed as an aerosol from release means 10 which comprised either one or two aerosol spray cans. The 35 filter tested was a No. 5 filter into which holes were drilled using 2.0mm, 2.5mm, 3mm and 3.5mm drill bits. The leaks generated by the 3mm and 3.5mm holes were detected

at 23°C, but not at 12°C. This indicates that although this method and kit in accordance with the present invention show acceptable performance, they are not foolproof at lower temperatures.

5

Example 11 - chemical filter test on Challenger tank
The general methodology of example 10 was applied to a the COLPRO of a Challenger tank, except that a No.1 filter was used. 1.5mm and 2.0mm diameter drill bits were
10 used to drill holes into the filter 2. The release means 10 comprised either 1 or 2 aerosol spray cans. In some cases, 1 can was used to generated a 30 second challenge, rather than the usual 15 second challenge. Using only 1 spray can, the 2.0mm hole (0.01% leak) was just
15 detectable if a 30 second challenge was used. The use of 2 cans for 15 seconds gave a greater detector signal and is preferable.

This shows that the kit and method in accordance with the
20 present invention are suitable for the testing of the filtration systems of mobile COLPRO facilities.

The embodiments of the present invention already demonstrated are concerned with the measurement of material transmitted through the filtration means of a typical COLPRO. The method and kit in accordance with the present invention also provide a method and kit respectively for measuring one or both of the air flow and overpressure, to be used in conjunction with the
30 material-transmission measurements exemplified above.

Example 12 - measurement of air flow

A manometer (not shown), preferably a micromanometer, is placed inside a facility that uses a filtration system.
35 The manometer has at least two ports suitable for the measurement of pressure. With the filtration system running, at least one of the ports is used to measure the

pressure inside the facility 5 that is generated by the flow of air from the air outlets. The pressure measurement from at least one other port is effectively used as a 'ground' measurement. The relative pressure 5 displayed by the manometer can, with the aid of suitable calibration tables, be used to calculate the rate of air flow through the filtration system. Remedial action can be taken should the measured air flow be too low or too high.

10

Example 13 - measurement of overpressure

A manometer (not shown), preferably a micromanometer, is placed inside a facility 5 that uses a filtration system. The manometer has at least two ports suitable for the 15 measurement of pressure. With the filtration system running, at least one of the ports is used to measure atmospheric pressure outside of the facility 5, whilst at least one other port is used to measure the pressure inside the facility. The pressure inside the facility 5 should 20 be greater than that outside by a desired amount (the desired overpressure). If this is not the case, the vents of the facility can be adjusted so as to achieve and maintain the desired overpressure. Overpressure is required to prevent the ingress or build-up of noxious 25 materials within the facility.

The present invention has demonstrated that it is possible to produce a sensitive, simple and reliable method (and associated kit) for the testing of filtration 30 systems. Furthermore, those skilled in the art will recognise that although the invention in suit has only been described with reference to the testing of COLPRO systems, the first and second aspects of the invention can be readily adapted to test the performance of many 35 filtration systems that are intended to remove one or more of particulate, chemical, biochemical and biological materials from gaseous carriers.

Claims

1. A method for the testing of a filtration system
5 comprising in sequence
 - a) release of material into a gaseous carrier;
 - b) passage of the gaseous carrier through filtration means; and
 - c) sensing for the presence of the material in the 10 gaseous carrier which has passed through the filtration means.
2. A method according to claim 1 wherein the release of the material involves the formation of an aerosol of 15 material in the gaseous carrier.
3. A method according to any preceding claim wherein the sensing of the presence of the material is effected by the use of a detection means.
20
4. A method according to any one of claims 1 to 3 wherein the material comprises particulate matter.
5. A method according to claim 4 wherein the release 25 means is one or more aerosol spray canister.
6. A method according to claim 4 wherein the release of material is effected by use of smoke generating means.
30
7. A method according to claim 6 wherein the release of material is effected by the use of one or more smoke generating machine.
8. A method according to claim 6 wherein the release of 35 material is effected by the use of one or more smoke bomb.

9. A method according to any one of claims 4 to 8 wherein the detection means comprises one of a light scattering device, a condensation nuclei counter, a photoelectric device or an ionisation detector.

5

10. A method according to any one of claims 1 to 4 wherein the material simulates a chemical warfare agent, wherein as benign material is used to simulate a toxin against which the filtration system is targeted.

10

11. A method according to claim 10 wherein the release means is one or more aerosol spray canister.

15

12. A method according to any one of claims 10 or 11 wherein the material is non-toxic.

13. A method according to any one of claims 10 to 12 wherein the material is methyl salicylate.

20

14. A method according to any one of claims 10 to 13 wherein the detection means comprises a chemical warfare agent detector.

25

15. A method according to claim 14 wherein the detection means comprises a GID chemical warfare detector.

30

16. A method according to any preceding claim further comprising the passage of the gaseous carrier through ducting means prior to passage through the filtration means.

35

17. A method according to any preceding claim wherein the filtration system is a collective protection filtration system.

18. A method according to any preceding claim wherein the filtration means comprises at least one filter capable of removing particulate material from the gaseous carrier.

5

19. A method according to any preceding claim wherein the filtration means comprises at least one filter capable of removing one or more of chemical warfare agents from the gaseous carrier.

10

20. A method according to any preceding claim wherein the method further comprises the measurement of air flow through the filtration means.

15

21. A method according to any preceding claim wherein the method further comprises the measurement of overpressure generated by the filtration system.

20

22. A kit for the testing of a filtration system comprising a material, release means capable of releasing the material into a gaseous carrier and detection means capable of sensing the presence of the material in a gaseous carrier.

25

23. A kit according to claim 22 wherein the release means comprises an aerosol generation means capable of releasing an aerosol of material into the gaseous carrier.

30

24. A kit according to claim 23 wherein the aerosol generation means comprises one or more aerosol spray canister.

35

25. A kit according to any one of claims 22 to 24 further comprising ducting means connectable to the input of the filtration system.

26. A kit according to any one of claims 22 to 25 further comprising a manometer.
27. A kit according to any one of claims 22 to 26 wherein
5 the release means comprises a means for the release of particulate matter.
28. A kit according to claim 27 wherein the means for the release of particulate matter comprises at least one
10 smoke bomb.
29. A kit according to claim 27 wherein the means for the release of particulate matter comprises at least one smoke-generating machine.
15
30. A kit according to any one of claims 27 to 29 wherein the detection means comprises any one of a light scattering device, a condensation nuclei counter, a photoelectric device or an ionisation detector.
20
31. A kit according to any one of claims 22 to 26 wherein the release means comprises a means for the release of material whose dispersant properties are similar to those of one or more chemical weapons.
25
32. A kit according to claim 31 wherein the detection means comprises a chemical warfare detector.
33. A kit according to claim 32 wherein the chemical warfare detector comprises a GID chemical warfare detector.
30
34. A kit according to any one of claims 31 to 33 wherein the material comprises methyl salicylate.
35. A kit according to any one of claims 22 to 34 wherein the filtration system comprises a collective

protection filtration system.

36. A kit according to any one of claims 22 to 35 wherein
the filtration system comprises at least one filter
5 capable of removing particulate matter from the
gaseous carrier.
37. A kit according to any one of claims 22 to 36 wherein
the filtration system comprises at least one filter
10 capable of removing one or more of chemical warfare
agents from the gaseous carrier.

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